as unrecognized terms of art. These misspellings have been corrected such that "emphmeris" replaces [emphamerie] and "Hadamard" replaces [hadema]. Each of these terms is well-known in the art.

The Objections To The Drawings:

The Examiner objected to Figure 4 as the number representations 1-8, 34 and 36 were not clearly defined in the specification. With respect to numbers 1-8, these are merely representative of the number of elements being multiplexed together. These numbers are merely illustrative as any number of elements could be multiplexed. However, for purposes of clarification, these numbers have been specifically identified in the specification in the second full paragraph on page 10. With regard to reference numbers 34 and 36, it is respectfully submitted that these are fully identified and described in the specification on the last line on page 10.

The 35 U.S.C. §103 Obviousness Objections:

The Examiner rejected claims 1, 2, 4-11 and 13-20 under 35 U.S.C. §103(a) as obvious over *Miura, et al* in view of *Chang, et al* and *Barrett, et al.* Claim 1 has been amended to reflect that the antenna is for communication with an equatorial satellite constellation. Moreover, the claimed antenna is configured to operate fully in only one dimension and thereby utilize a significantly reduced number of radiation elements as compared to prior designs such as disclosed in *Miura, et al* which utilizes a two-dimensional radiation element configuration. Due to the antenna's use with an equatorial satellite constellation, the antenna design of the present invention will allow the antenna to orient itself such that the fan beam direction will be aligned within the equatorial area at any given altitude. This is significant as the claimed design is able to form an arc from one end of the horizon to the other end of the horizon and can talk to slowly moving satellites. It is therefore submitted that Claim 1 clearly defines over the art of record.

Applicants' respectfully traverse the Examiner's rejections of Claims 7 and 13. It is submitted that these claims define over the art of record as originally filed. Claims 7 and 13 require use with an equatorial satellite constellation. It is submitted that Claims 7 and 13 define over the art of record for this reason alone as none of the references of record teach or suggest a phased array antenna as required by Claim 7 for use with an equatorial satellite constellation or the method of Claim 13. Moreover, Claims 7 and 13 also require that the major axis of each of the plurality of radiation elements is positioned such that the wavefront of an intended signal is in alignment therewith. This is neither taught nor suggested by any of

the references of record, as the intended signal would always be in alignment with some of the radiation elements and not in alignment with others. It is respectfully requested that the Examiner reconsider and withdraw the obviousness rejections as to Claim 7 and 13.

It is therefore respectfully submitted that claims 1, 7 and 13 are allowable over the art of record and that dependent claims 2-6, 8-12 and 14-20 which depend directly or indirectly therefrom are also allowable over the art of record for the same reasons provided above in connection with claims 1, 7 and 13.

It is submitted that newly added Claims 21 - 37 also clearly define over the art of record.

CONCLUSION

It is respectfully submitted that all objections and rejections of record have been overcome and that all pending claims are in a condition for allowance. A Notice of Allowance is therefore respectfully solicited.

If the Examiner should have any questions, he is urged to contact the undersigned.

Respectfully submitted,
DONALD C. D. CHANG, ET AL.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In The Title:

Kindly substitute the following for the title:

AN IMPROVED PHASED ARRAY TERMINAL FOR [EQUITORIAL] EQUATORIAL SATELLITE CONSTELLATIONS

In The Specification:

Kindly substitute the following for the first paragraph on page 1:

The present invention relates generally to a phased array antenna. More specifically, the present invention relates to a low cost, low profile tracking phased array antenna for use on a commercial satellite terminal for **[equitorial]** **equatorial** satellite constellation systems.

Kindly substitute the following for the first full paragraph on page 3:

It is a further object of the present invention to provide a low profile tracking phased array antenna of a terminal that is for use on a commercial **[equitorial]** **equatorial** satellite constellation.

Kindly substitute the following for the second full paragraph on page 3:

It is still another object of the present invention to provide a low profile tracking phased array antenna for use on either a fixed or mobile consumer commercial satellite terminal for **[equitorial]** **equatorial** satellite constellations.

Kindly substitute the following for the third full paragraph on page 3:

It is still a further object of the present invention to provide a tracking phased array antenna that is suitable for use on a commercial satellite terminal for **[equitorial]** **equatorial** satellite constellations and is intended as a consumer product which provides high performance, is relatively inexpensive, and has a low profile.

Kindly substitute the following for first full paragraph on page 6:

Figure 1 illustrates an environmental view of the disclosed antenna in accordance with a preferred embodiment of the present invention. As shown, a preferred antenna 10 is positioned in a fixed position on the ground and is in communication with a plurality of orbiting satellites 12 to transmit signals thereto and receive signals therefrom. Another

antenna 10 is attached to an automobile travelling along the ground which is also in communication with a plurality of orbiting satellites 12 to transmit signals thereto and receive signals therefrom. The disclosed antenna may also be attached to other mobile vehicles such as aircrafts or boats. The satellites 12 are preferably medium earth orbit **[equitorial]** **equatorial** satellites.

Kindly substitute the following for the paragraph that begins on page 6 and ends on page 7:

As shown in Figure **[1]** 2, the antenna 10 includes a plurality of antenna radiation elements 14 that are positioned on a circular plate 16. The circular plate 16 is a rotating plate that rotates about a center axis, as will be described further herein.

Kindly substitute the first full paragraph on page 7:

In a preferred embodiment, the rotating plate 16 is less than one inch (1") thick and has a diameter of fifteen inches (15") or less. Obviously, the dimensions of the rotating plate 16 may vary. However, the greater the diameter and thickness, the larger and more costly the antenna 10 will become. As shown in Figure **[2]** 3, the antenna radiation elements 14 are preferably constructed using a plurality of parallel slotted waveguides 18. However, a variety of different antenna radiation elements may instead be utilized, such as patch arrays. The operation of the disclosed antenna configuration is described in a receive mode only. The corresponding transmission mode operation can be easily understood by one of skill in the art via reciprocity.

Kindly substitute the paragraph that begins on page 7 and ends on page 8:

In accordance with a preferred embodiment, each slotted waveguide element 18 is approximately 10 wavelengths long. In one embodiment, 16 long waveguide elements 18 are positioned on the circular plate 16. The waveguide elements 18 are grouped into two groups and are interlaced, as shown in Figure **[1]** 3, such that waveguide 1a and waveguide 1b begin at opposite ends of the circular plate 16 and overlap one another. Each of the individual waveguides are preferably separated by one-half wavelength (½ λ). Therefore, the total aperture in which the waveguide elements are positioned is about 10 x 10 wavelength in a square and the expected peak gain of a straight out or boresight beam from this aperture is about 28 to 30 dB. While the circular plate 16 rotates, rotating the antenna radiation elements 14 therewith, the vertical position of the circular plate 16 remains generally stationary. It should be understood that the number of waveguides positioned on the circular

plate may vary, however, the preferred number of waveguide elements is between 10 and 20. Further, the distance between the waveguide elements and their length may also vary.

Kindly substitute the following for the paragraph that begins on page 10 and ends on page 11:

Specifically, as shown in Figure 4, each of the pair of sixteen slotted waveguides 18, **numbered 1 through 8 for purposes of illustration,** will individually intercept an incoming wave. The waves will be intercepted by the phased array elements 18. The top portion of Figure 4 is a schematic of a Ku band receive array. Similar architectures can be utilized for other frequency bands, such as L-band, S-band, and Ka band. Obviously, the present invention may be utilized for each of these frequency bands. As schematically represented by reference numerals 34, 36, the waves received at the waveguide elements 18 are processed by circuitry associated with each of the elements. The incoming wave is then amplified by a respective linear amplifier 38 before being passed to a conventional band pass filter 40 where the signal is filtered. After the signal has been filtered, it is then coded at a code generator 42 before being transferred to a multiplexer 44. The multiplexed signal is passed to an amplifier 46 before being multiplexed and then converted to a digital stream 48 by an analog-to-digital converter 50.

Kindly substitute the following for the paragraph that begins on page 13 and ends on page 14:

Similar to the antenna disclosed in the prior figures, the entire receiving antenna and tracking processing of this preferred embodiment is through the low profile, one dimensional radiation elements 14. The radiation elements 14 are again preferably placed in parallel on the circular plate 16 which rotates about its center axis. The long radiation elements 16 are also aligned along the intended incoming waveform by the rotating circular plate 16 and then subjected to multiple beamforming through fast fourier transforms (FFT) at the digital multibeam beamforming device 54. The outputs of the digital multibeam beamforming device 54 through FFT are associated with signals from various directions covered by the different (contiguous) beams. The outputs of the FFT will be fed into a retrodirective processing mechanism, as described below, to determine where the intended signal is coming from and then to send the transmit signal to the same direction. The low cost tracking is accomplished by retrodirectivity. The history of the beam positioning will be stored in the terminal as a reference for the satellite **[emphamerie] emphmeris**.

Kindly substitute the following for the first full paragraph on page 14:

The received signals are again multiplexed into a single microwave stream via known CDMA techniques to reduce the component counts and the ultimate cost of the ground terminals. Incorporating the unique multiple digital beam forming technique with multiplexing provides contiguous multiple receive beams. The receiver monitors the signals from all the multiple beams simultaneously. The outputs of the digital multiple beamformer are then indexed through a set of orthogonal codes, such as **[hadema]** **Hadamard** code, each of which represents the unique beam direction. By identifying the code of the signals locked onto the receiver, the location where the signal is coming from has been identified as well as the corresponding phase slope of the received aperture.

Kindly substitute the following for the first full paragraph on page 16:

As for **[equitorial]** **equatorial** non-geosynchronous constellations, users can use the disclosed terminal to avoid interruption during handover. During transition, there will be one satellite coming in and another satellite going out from a user's FOV. Furthermore, there is only a limited time window when the satellites are at the same elevation or near the same elevation, but at a different azimuth angle. The disclosed antenna can form two beams pointed towards these two satellites simultaneously. Consequently, it can provide the capability of "connect before break" during the hand over phase.

In the Claims:

Kindly substitute the following for pending Claim 1:

1. An antenna **for an equatorial satellite constellation** for use on a commercial satellite terminal, comprising:

a generally circular rotating plate for mechanically scanning for wave signals in the azimuth direction;

a plurality of radiation elements positioned on said circular plate for electronically scanning for wave signals in elevation; and

a multiplexor associated with each of said plurality of radiation elements for consolidating the individual wave signals received at each of said plurality of radiation elements to an analog bit stream;

an analog to digital converter for converting said analog bit stream to a digital bit stream;

circuitry for forming multiple digital beams from said digital bit stream; and

a digital receiver for converting said digital beamforms into an information signal.

Kindly substitute the following for pending Claim 6:

6. The antenna of Claim 1, wherein said radiation elements form multiple beams for communicating with a plurality of satellites in an **[equitorial]** **equatorial** satellite constellation.

Kindly substitute the following for pending Claim 7:

8. A phased array antenna for an **[equitorial]** **equatorial** satellite constellation, comprising:

a rotating plate for mechanically scanning for a wavefront of wave signals in an azimuth direction;

a plurality of radiation elements positioned on said rotating plate for receiving a plurality of individual waves;

apparatus for positioning said radiation elements such that a wavefront of an intended signal will be in alignment with a major axis of said plurality of radiation elements;

a plurality of multiplexer devices, each in communication with one of said plurality of radiation elements for converting said plurality of received individual waves into an analog bit stream;

an analog to digital converter for converting said analog bit stream to a digital bit stream;

a device for forming multiple digital beam forms from said digital bit stream; and

a digital receiver for processing said multiple digital beams.

Kindly substitute the following for pending Claim 9:

9. The antenna of claim 7, wherein said antenna transmits said multiple digital beams to a plurality of satellites in the **[equitorial]** **equatorial** satellite constellation.

Kindly substitute the following for pending Claim 13:

14. A method for forming multiple beams at a commercial satellite antenna comprising:

providing a plurality of radiation elements on a surface of said commercial satellite antenna for receiving a plurality of individual wave signals;

rotating said plurality of radiation elements such that a wavefront of said plurality of individual wave signals is in alignment with a major axis of said plurality of radiation elements;

consolidating said plurality of wave signals into a single analog signal;

forming multiple beam forms from said single analog signal; and

transmitting said multiple beam forms to a plurality of satellites in an **[equitorial]** equatorial satellite constellation.

Kindly add the following additional claims:

21. (New) A phased array antenna for an equatorial satellite constellation, comprising:

a rotating plate for electrically scanning for a wavefront of wave signals in elevation and for mechanically scanning for said wavefront of wave signals in an azimuth direction;

a plurality of elongated radiation elements positioned on said rotating plate for receiving a plurality of individual waves, each of said plurality of radiation elements having a major axis and a minor axis;

apparatus associated with each of said plurality of radiation elements for consolidating the wave signals received at each of said plurality of radiation elements into a first bit stream; and

a multiple beam former for forming multiple beams from said first bit stream.

22. (New) The antenna of Claim 21, further comprising:

a converter for converting said first bit stream from an analog bit stream to a digital bit stream, which digital bit stream is received by said multiple beam former.

23. (New) The antenna of Claim 21, wherein each of said plurality of elongated radiation elements are cross-slotted waveguides, which are aligned parallel to one another on the antenna.

24. (New) The antenna of Claim 23, wherein each of said plurality of radiation elements includes a slotted septum therein.

25. (New) The antenna of Claim 21, wherein the antenna may be utilized on a mobile vehicle.

26. (New) The antenna of Claim 21, wherein said apparatus for consolidating the wave signals is a multiplexer.

27. (New) The antenna of Claim 26, wherein said multiplexer is a code division multiplexer.

28. (New) The antenna of Claim 21, wherein the antenna is configured with a low profile.

29. (New) The antenna of Claim 21, wherein the antenna is in communication with a commercial satellite terminal.

30. (New) A method of communicating with an equatorial satellite constellation, comprising:

providing a plurality of generally planar radiation elements on a surface of a commercial satellite antenna;

rotating said satellite antenna such that a wavefront of a plurality of individual wave signals is in alignment with a major axis of said plurality of radiation elements;

consolidating said plurality of wave signals into a single bit stream;

forming multiple beam forms from said single bit stream; and

transmitting said multiple beam forms to a plurality of satellites in the equatorial satellite constellation.

31. (New) The method of Claim 30, further comprising:

mechanically scanning a field of view for said wave signals in azimuth.

32. (New) The method of Claim 31, further comprising:

electronically scanning said field of view for said wave signals in elevation.

33. (New) The method of Claim 30, further comprising:

converting said single signal to a digital bit stream; and

forming multiple digital beam forms from said digital bit stream.

34. (New) The method of Claim 33, further comprising:

utilizing FFT techniques to form said multiple digital beam forms to provide for satellite retrodirectivity.

35. (New) The method of Claim 31, further comprising:

providing seamless handover from one satellite to another without interruption.

36. (New) The method of Claim 31, further comprising:

monitoring signal strength from adjacent received individual wave signals in order to track other satellites in the equatorial satellite constellation.

37. (New) A commercial satellite terminal for an equatorial satellite constellation comprising:

an antenna including,

a generally circular rotating plate for mechanically scanning for wave signals in the azimuth direction;

a plurality of elongated radiation elements positioned generally parallel to one another on said circular plate for electronically scanning for wave signals in elevation;

a multiplexer associated with each of said plurality of radiation elements for consolidating the individual wave signals received at each of said plurality of radiation elements to a first bit stream; and

a multiple beam former for forming multiple beams from said first bit stream.